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FORECASTING AND VOLATILITY ANALYSIS OF INTERNATIONAL SOYBEAN PRICE FROM 2004 UNTIL 2014

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Abstract.Soybean is the important commodity in Indonesia because its benefit. As the source of protein, soybean has been known and used for many food products such as tofu, tempe, ketchup, etc and most of the people of Indonesia tend to eat Tofu and tempe. The problem arises because Indonesia has become the importer of soybean and the international soybean price is volatile since 10 years. The price volatility can rise uncertainties and makes financial & strategic investment planning more difficult especially for soybean processor. Based on that problem, this paper is aimed to know the future price forecasting and the volatility of international soybean price in the next ten years. The result of this paper would be a baseline to hedge toward risk in soybean industry area. The sample of data is monthly international soybean price in periode of December 2004 until November 2014, counted for 120 observations. This financial time series data could be analyzed using Autoreggresive Integrated Moving Average (ARIMA) to show the result of the future price forecasting and volatily of soybean. There are three models tested here: ARIMA(1,1,0), ARIMA(0,1,1), and ARIMA(1,1,1). The result of this study shows that ARIMA(1,1,0) is the best model to forecast the international soybean price in the next ten years. Later in the forecasting result, there is strategy that can be recommended for soybean industry and importer to hedge against the volatility. The price predicted to rise sharply start from November 2016 until July 2018 so the soybean processor and importer especially should be prepared to establish forward futures contract before October 2016 for period November 2016 until November 2017 and December 2017 until July 2018 to lock the price against the upcoming trend that will come. After that the forward future contract shoukd be set once again to encounter with the upcoming trend which expected occur the next three years until August 2022.

Keywords : soybean, volatility, future price, forecasting, ARIMA

Introduction

in this final project, the author wants to analysis the future price forecasting and the volatility that appear in international soybean price. The problem that need to be analyzed in this research is the international soybean future price forecasting and its volatility which reflects business risk in soybean industry. It can affect the soybean industry in Indonesia like 2 years ago. The volatility price of soybean can raise the uncertainties that makes the strategy and financial of the industry more difficult. This study is aimed to forecast international soybean price in forseeable ten years. The result of this research would be recommendation to hedge toward risk in soybean industry area.

Literature Review

risk

According to Carl Olsson (2002), risk is the uncertainty of future outcomes. This short and simple statement suggest that risk is something that happens in the future but cannot predicted exactly today because there is uncertainty. Carl Olsson divided uncertainty into two dimensions:

1. The range of possible outcomes

The outcomes resulting from an event or an action can be very limited or unknown.

2. The probability of an outcome occurring

Probability is the chance that a particular output will occur. In some situation, we often cannot calculate the exact probability of the output but we only can estimate it. However, in many other situation it may not possible to measure the probability or estimate at all such as tsunami or flood.
Generally, we are very bad to assess the probabilities in events. It is happened because we do not have any informations of the event and also there are any factors such as bias and poor processing of available data.

Volatility
Volatility is the amount of uncertainty or risk about the size of changes in a security's value. Volatility can be divided into two parts which are high volatility and low volatility. High volatility means that a security's value can potentially be spreas out over a larger range of values. This means that the price can change dramatically over a short time period in either direction. A low volatility means that the security's value does not fluctuate dramatically, but changes in value at a steady pace over a period of time (Investopedia.com,2014).
Analyzing volatility is crucial especially for decision makers because variability raised difficulties in financial planning. The same problem could happen to traders, exporters, and importers whose play in international exchange markets. High volatility and variability can lead to a chance in suffering big loss or gaining huge profit (Gujarati, 2004). The wider swings in a price mean the more difficult to not take attention to it. It also can be turned into more complex way when at certain cash flows are needed at a specific time, higher volatility can result in a greater chance of a shortfall.

Autoreggresive Integrated Moving Average (ARIMA)
One of the familiar time series data model is Autoregressive Integrated Moving Average (ARIMA). This model is developed by George EP Box and Gwilym M Jenkins (1976) so that the ARIMA model is often called as Box-Jenkins time series method. According to Gujarati (2004), the emphasis of these methods is not on constructing single-equation or simultaneous-equation models but on analyzing the probabilistic, or stochastic, properties of economic time series on their own under the philosophy let the data speak for themselves. Unlike the regression models, in which Yt is explained by k regressors X1, X2, X3, . . . , Xk , the BJ-type time series models allow Yt to be explained by past, or lagged, values of Y itself and stochastic error terms. For this reason, ARIMA models are sometimes called atheoretic models because they are not derived from any economic theory—and economic theories are often the basis of simultaneous-equation models.
The requirement of this model is the stationary of the time series data that we used. The time series data will stationare if the data moving shows the constant pattern from time to time, either its mean or the variance. If the time series data is not stationare in level, it is needed to be stationare through difference process. Difference process is the process to find the difference between the data of the period with the previous period sequentially.
AR, MA, or ARMA model with the stationare data through this difference process is called ARIMA model. A time series data (Yt) is called follow this model if the series with the difference-d (Wt= Δ^d Y) is stationare ARMA process. If Wt is ARMA (p,q), then Yt is called ARIMA (p,d,q). practically, d ≤ 2. If Yt is ARIMA (p,1,q), with Wt = Yt – Yt-1 then :

$$W_t = \beta_0 + \beta_1 W_{t-1} + \beta_2 W_{t-2} + \dots + \beta_p W_{t-p} + e_t + \alpha_1 e_{t-1} + \alpha_2 e_{t-2} + \dots + \alpha_q e_{t-q}$$

Methodology

The problem identification explains the problem that will be analyzes further in this research. In this research, the problem identification arises from the volatility of international soybean prices. The volatility prices indicate and uncertainty in soybean industry that cause the risk especially for producer. After that, literature review is conducted from scientific sources in order to get adequate knowledge that needed to carry out the research. Next is data collection. We collected soybean price data in form of time series data. In data analysis, we use ARIMA model as a method of analysis and forecasting procedure will be performed to analyze the data process and to forecast the volatility of international soybean prices for the next 1 year. In the end, conclusion will be made in form of findings summary within this research.

Forecasting procedure consist of six steps:

1. Autocorrelation Test
   To ensure whether to use time series model or not. Time series models like autoregressive (AR), moving average (MA) errors, or both are useful to modelling data with serial correlation. One way to test for autocorrelation is through the correlogram which shows the empirical pattern of correlation between residuals and their own past values
2. Stationary test
   The data that we used must be stationary which is must not be suffered from trend. If the data that is used is not stationary, then the data maybe become stationary through the differencing process. Therefore, if the data have to difference at d times to make it stationary and the apply the ARMA (p, q) model to it, then the ARMA (p, q) model become ARIMA (p, d, q) model.
   Augmented Dickey-Fuller (ADF) Test is one way to test the stationarity in the data. The procedures to check the stationarity of the data is with comparing the value of ADF statistic with the critical value. If the absolute value of ADF statistic higher than the critical value, then the data is stationary. Otherwise, if the absolute value of ADF statistic is lower than the critical value, then the data is not stationary.
3. ARIMA model identification
   The general method that used to indetify the ARIMA model is through correlogram, which is simply the plots of Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF) against the lag length. The ACF and PACF patterns are used to identify the tentative ARIMA model.
4. Estimating The Parameter
   The appropriate ARIMA model should contains all significant cefficients. If there are two or more models that might be appropriate, the best model is selected based on goodness of fit model (with R^2 test and probability test) and the lowest score for both Akaike Info Criterion (AIC) & Schwarz Criterion (SC) score.
5. Diagnostic Test/Evaluating the Model
   One simple test of the chosen model is to see if the residuals estimated from this model are white noise through its correlogram. The evidence that the residuals are white noise is all coefficient of ACF and PACF is not significant until a certain lag. The Ljung-Box (LB) test also can be used to check the residuals. If the value of LB statistic lower than the critical value from the chi squares X^2 distribution table then the residuals are white noise. On the contrary, if the value of LB statistic higher than the critical value from the chi squares X^2 distribution table then the residuals are not white noise. If the residuals of chosen model are white noise, then the chosen model are accepted to fit in the data.
6. Forecasting
   The end of this step is to make a forecasting based on the fit model that has chosen before. Forecasting will use the historical international soybean price which is monthly average international soybean prices. The next one year international soybean prices prediction and the volatility analysis will be conducted in this research.

Data Analysis

Autocorrelation Test

The first step to do this research is checking the autocorrelation in the data. In the presence of lagged depenent variables, OLS estimates are biased and inconsistent. However, if the data is serially correlated, than time series model is required to modeling the data.

Sample: 2004M12 2014M11
Included observations: 120

<table>
<tr><th>Autocorrelation</th><th>Partial Correlation</th><th></th><th>AC</th><th>PAC</th><th>Q-Stat</th><th>Prob</th></tr>
<tr><td>.|*******</td><td>.|*******</td><td>1</td><td>0.963</td><td>0.963</td><td>114.05</td><td>0.000</td></tr>
<tr><td>.|*******</td><td>**|. |</td><td>2</td><td>0.909</td><td>-0.249</td><td>216.55</td><td>0.000</td></tr>
<tr><td>.|******|</td><td>.|. |</td><td>3</td><td>0.850</td><td>-0.049</td><td>306.94</td><td>0.000</td></tr>
<tr><td>.|******|</td><td>.|* |</td><td>4</td><td>0.800</td><td>0.118</td><td>387.69</td><td>0.000</td></tr>
<tr><td>.|*****|</td><td>.|. |</td><td>5</td><td>0.752</td><td>-0.063</td><td>459.59</td><td>0.000</td></tr>
<tr><td>.|*****|</td><td>.|. |</td><td>6</td><td>0.706</td><td>-0.002</td><td>523.57</td><td>0.000</td></tr>
<tr><td>.|*****|</td><td>.|* |</td><td>7</td><td>0.667</td><td>0.086</td><td>581.26</td><td>0.000</td></tr>
<tr><td>.|*****|</td><td>.|. |</td><td>8</td><td>0.631</td><td>-0.042</td><td>633.34</td><td>0.000</td></tr>
<tr><td>.|**** |</td><td>.|* |</td><td>9</td><td>0.606</td><td>0.123</td><td>681.74</td><td>0.000</td></tr>
<tr><td>.|**** |</td><td>.|. |</td><td>10</td><td>0.585</td><td>0.009</td><td>727.24</td><td>0.000</td></tr>
<tr><td>.|**** |</td><td>.|. |</td><td>11</td><td>0.565</td><td>-0.043</td><td>770.05</td><td>0.000</td></tr>
<tr><td>.|**** |</td><td>*|. |</td><td>12</td><td>0.534</td><td>-0.139</td><td>808.64</td><td>0.000</td></tr>
<tr><td>.|**** |</td><td>.|. |</td><td>13</td><td>0.501</td><td>0.042</td><td>842.98</td><td>0.000</td></tr>
<tr><td>.|*** |</td><td>.|. |</td><td>14</td><td>0.473</td><td>0.055</td><td>873.82</td><td>0.000</td></tr>
<tr><td>.|*** |</td><td>.|. |</td><td>15</td><td>0.445</td><td>-0.065</td><td>901.38</td><td>0.000</td></tr>
<tr><td>.|*** |</td><td>.|. |</td><td>16</td><td>0.419</td><td>0.036</td><td>926.09</td><td>0.000</td></tr>
<tr><td>.|*** |</td><td>.|. |</td><td>17</td><td>0.392</td><td>-0.019</td><td>947.97</td><td>0.000</td></tr>
<tr><td>.|*** |</td><td>*|. |</td><td>18</td><td>0.364</td><td>-0.067</td><td>967.03</td><td>0.000</td></tr>
<tr><td>.|** |</td><td>.|. |</td><td>19</td><td>0.333</td><td>-0.034</td><td>983.11</td><td>0.000</td></tr>
<tr><td>.|** |</td><td>*|. |</td><td>20</td><td>0.299</td><td>-0.070</td><td>996.19</td><td>0.000</td></tr>
<tr><td>.|** |</td><td>*|. |</td><td>21</td><td>0.258</td><td>-0.140</td><td>1006.0</td><td>0.000</td></tr>
<tr><td>.|* |</td><td>.|. |</td><td>22</td><td>0.212</td><td>-0.020</td><td>1012.7</td><td>0.000</td></tr>
<tr><td>.|* |</td><td>.|. |</td><td>23</td><td>0.170</td><td>0.050</td><td>1017.1</td><td>0.000</td></tr>
<tr><td>.|* |</td><td>.|. |</td><td>24</td><td>0.132</td><td>-0.019</td><td>1019.7</td><td>0.000</td></tr>
<tr><td>.|* |</td><td>.|. |</td><td>25</td><td>0.100</td><td>0.012</td><td>1021.3</td><td>0.000</td></tr>
<tr><td>.|* |</td><td>.|. |</td><td>26</td><td>0.075</td><td>0.052</td><td>1022.2</td><td>0.000</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>27</td><td>0.060</td><td>0.055</td><td>1022.7</td><td>0.000</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>28</td><td>0.050</td><td>-0.021</td><td>1023.1</td><td>0.000</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>29</td><td>0.042</td><td>0.010</td><td>1023.4</td><td>0.000</td></tr>
<tr><td>.|. |</td><td>.|* |</td><td>30</td><td>0.039</td><td>0.084</td><td>1023.7</td><td>0.000</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>31</td><td>0.043</td><td>0.072</td><td>1024.0</td><td>0.000</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>32</td><td>0.047</td><td>0.004</td><td>1024.3</td><td>0.000</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>33</td><td>0.047</td><td>-0.012</td><td>1024.7</td><td>0.000</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>34</td><td>0.048</td><td>0.053</td><td>1025.1</td><td>0.000</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>35</td><td>0.049</td><td>-0.010</td><td>1025.5</td><td>0.000</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>36</td><td>0.046</td><td>-0.059</td><td>1025.9</td><td>0.000</td></tr>
</table>

the correlogram shows substansial and persistent autocorrelation in the residuals. The autocorrelation is positive with slow and linear decay and all the Q-statistics probability values are significant. It can be conclude that our time series data is serially correlated and time series model like Autoregressive (AR) or Moving Average (MA) should be used to modelling the data.

Stationary Test

The Augmented Dikey-Fuller test is used to test the stationary.

Null Hypothesis: D(PRICE) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.792669	0.0000
Test critical values:	1% level	-4.037668	
	5% level	-3.448348	
	10% level	-3.149326	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(PRICE,2)
Method: Least Squares
Date: 01/04/15 Time: 11:20
Sample (adjusted): 2005M02 2014M11
Included observations: 118 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(PRICE(-1))	-0.695490	0.089249	-7.792669	0.0000
C	5.019935	4.965452	1.010972	0.3142
@TREND("2004M12")	-0.063891	0.071450	-0.894211	0.3731

R-squared	0.345621	Mean dependent var	0.236102
Adjusted R-squared	0.334240	S.D. dependent var	32.12833
S.E. of regression	26.21482	Akaike info criterion	9.395622
Sum squared resid	79029.93	Schwarz criterion	9.466063
Log likelihood	-551.3417	Hannan-Quinn criter.	9.424223
F-statistic	30.36956	Durbin-Watson stat	1.984321
Prob(F-statistic)	0.000000		

in the table above, the absolute value of ADF test statistic is higher than the absolute value of the other three test critical values. The probability value of ADF test statistic is also significant which is 0.0000. it can be concluded that the data is stationary in the 1st difference. The trend behavior also eliminated which it shows in the non-significant probability value of trend coefficient. The probability value of trend is 0.3731 which are not significant.

ARIMA Model Identification

After the data is checked for stationarity, the next step to do is to identify the appropriate ARIMA model. The standard method that used to choose the appropriate ARIMA model is through the correlogram by looking at ACF and PACF patterns. In this case, the correlogram of 1st difference is used because the data is stationary in 1st difference.

Sample: 2004M12 2014M11
Included observations: 119

<table>
<tr><th>Autocorrelation</th><th>Partial Correlation</th><th></th><th>AC</th><th>PAC</th><th>Q-Stat</th><th>Prob</th></tr>
<tr><td>.|** |</td><td>.|** |</td><td>1</td><td>0.313</td><td>0.313</td><td>11.945</td><td>0.001</td></tr>
<tr><td>.|* |</td><td>.|. |</td><td>2</td><td>0.101</td><td>0.004</td><td>13.211</td><td>0.001</td></tr>
<tr><td>*|. |</td><td>*|. |</td><td>3</td><td>-0.086</td><td>-0.131</td><td>14.122</td><td>0.003</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>4</td><td>-0.041</td><td>0.026</td><td>14.328</td><td>0.006</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>5</td><td>-0.036</td><td>-0.015</td><td>14.488</td><td>0.013</td></tr>
<tr><td>*|. |</td><td>*|. |</td><td>6</td><td>-0.093</td><td>-0.103</td><td>15.600</td><td>0.016</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>7</td><td>-0.056</td><td>0.002</td><td>16.008</td><td>0.025</td></tr>
<tr><td>**|. |</td><td>**|. |</td><td>8</td><td>-0.266</td><td>-0.271</td><td>25.217</td><td>0.001</td></tr>
<tr><td>*|. |</td><td>.|. |</td><td>9</td><td>-0.136</td><td>0.004</td><td>27.647</td><td>0.001</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>10</td><td>-0.031</td><td>0.051</td><td>27.774</td><td>0.002</td></tr>
<tr><td>.|* |</td><td>.|* |</td><td>11</td><td>0.210</td><td>0.181</td><td>33.679</td><td>0.000</td></tr>
<tr><td>.|. |</td><td>*|. |</td><td>12</td><td>0.035</td><td>-0.136</td><td>33.847</td><td>0.001</td></tr>
<tr><td>*|. |</td><td>*|. |</td><td>13</td><td>-0.092</td><td>-0.131</td><td>35.009</td><td>0.001</td></tr>
<tr><td>.|. |</td><td>.|* |</td><td>14</td><td>-0.006</td><td>0.086</td><td>35.014</td><td>0.001</td></tr>
<tr><td>.|. |</td><td>*|. |</td><td>15</td><td>-0.058</td><td>-0.084</td><td>35.480</td><td>0.002</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>16</td><td>0.017</td><td>-0.034</td><td>35.519</td><td>0.003</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>17</td><td>0.038</td><td>0.068</td><td>35.719</td><td>0.005</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>18</td><td>0.058</td><td>-0.008</td><td>36.204</td><td>0.007</td></tr>
<tr><td>.|. |</td><td>.|* |</td><td>19</td><td>0.042</td><td>0.127</td><td>36.458</td><td>0.009</td></tr>
<tr><td>.|* |</td><td>.|* |</td><td>20</td><td>0.109</td><td>0.121</td><td>38.194</td><td>0.008</td></tr>
<tr><td>.|. |</td><td>*|. |</td><td>21</td><td>0.060</td><td>-0.118</td><td>38.725</td><td>0.011</td></tr>
<tr><td>.|. |</td><td>*|. |</td><td>22</td><td>-0.016</td><td>-0.093</td><td>38.764</td><td>0.015</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>23</td><td>-0.035</td><td>0.031</td><td>38.952</td><td>0.020</td></tr>
<tr><td>*|. |</td><td>*|. |</td><td>24</td><td>-0.139</td><td>-0.096</td><td>41.865</td><td>0.013</td></tr>
<tr><td>*|. |</td><td>.|. |</td><td>25</td><td>-0.097</td><td>-0.057</td><td>43.309</td><td>0.013</td></tr>
<tr><td>*|. |</td><td>.|. |</td><td>26</td><td>-0.144</td><td>-0.055</td><td>46.528</td><td>0.008</td></tr>
<tr><td>*|. |</td><td>.|. |</td><td>27</td><td>-0.089</td><td>-0.003</td><td>47.770</td><td>0.008</td></tr>
<tr><td>*|. |</td><td>.|. |</td><td>28</td><td>-0.072</td><td>-0.023</td><td>48.587</td><td>0.009</td></tr>
<tr><td>*|. |</td><td>*|. |</td><td>29</td><td>-0.104</td><td>-0.102</td><td>50.326</td><td>0.008</td></tr>
<tr><td>*|. |</td><td>*|. |</td><td>30</td><td>-0.086</td><td>-0.138</td><td>51.510</td><td>0.009</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>31</td><td>0.024</td><td>0.004</td><td>51.607</td><td>0.012</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>32</td><td>0.059</td><td>0.018</td><td>52.176</td><td>0.014</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>33</td><td>0.041</td><td>0.013</td><td>52.456</td><td>0.017</td></tr>
<tr><td>.|. |</td><td>*|. |</td><td>34</td><td>0.035</td><td>-0.080</td><td>52.659</td><td>0.022</td></tr>
<tr><td>.|* |</td><td>.|* |</td><td>35</td><td>0.139</td><td>0.205</td><td>55.951</td><td>0.014</td></tr>
<tr><td>.|* |</td><td>.|. |</td><td>36</td><td>0.091</td><td>0.014</td><td>57.384</td><td>0.013</td></tr>
</table>

The ACF and PACF pattern dies down around lag 1 and lag 2, This is a sign of ARMA model. Thus, the tentative ARMA models estimation for 1st Difference of International Soybean monthly price are ARIMA (1,1,0) ARIMA (0,1,1) ARIMA (1,1,1).

Estimating the Parameter

The parameters that the author used are the probability value and also the AIC and SC scores.

Model	**AIC**	**SC**	**Probability**
ARIMA (1,1,0)	9.385602	9.432563	(*0.0005)
ARIMA (0,1,1)	9.392064	9.438772	(*0.0034)

From the data above, ARIMA (1,1,0) model is the best fit for forecasting this research.

Evaluating the Model

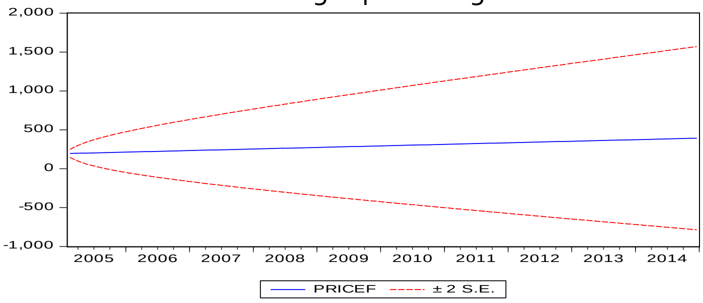
Sample: 2004M12 2014M11
Included observations: 118
Q-statistic probabilities adjusted for 1 ARMA term

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|. |	.|. |	1	-0.000	-0.000	3.E-05	
.|. |	.|. |	2	0.047	0.047	0.2668	0.605
*|. |	*|. |	3	-0.132	-0.132	2.4059	0.300
.|. |	.|. |	4	-0.008	-0.010	2.4138	0.491
.|. |	.|. |	5	-0.001	0.012	2.4140	0.660
*|. |	*|. |	6	-0.084	-0.103	3.3106	0.652
.|. |	.|. |	7	0.055	0.054	3.6915	0.718
**|. |	**|. |	8	-0.257	-0.256	12.196	0.094
.|. |	*|. |	9	-0.060	-0.091	12.671	0.124
.|. |	.|. |	10	-0.062	-0.031	13.172	0.155
.|** |	.|* |	11	0.254	0.207	21.690	0.017
.|. |	.|. |	12	0.002	-0.031	21.691	0.027
*|. |	*|. |	13	-0.122	-0.169	23.695	0.022
.|. |	.|. |	14	0.042	0.058	23.931	0.032
*|. |	.|. |	15	-0.073	-0.054	24.661	0.038
.|. |	*|. |	16	0.023	-0.078	24.737	0.054
.|. |	.|. |	17	0.017	0.047	24.780	0.074
.|. |	.|. |	18	0.044	-0.032	25.054	0.094
.|. |	.|* |	19	-0.006	0.078	25.058	0.123
.|* |	.|* |	20	0.096	0.177	26.376	0.120
.|. |	.|. |	21	0.041	-0.033	26.625	0.146
.|. |	*|. |	22	-0.026	-0.110	26.728	0.180
.|. |	.|. |	23	0.009	0.027	26.741	0.221
*|. |	*|. |	24	-0.121	-0.070	28.954	0.182
.|. |	.|. |	25	-0.020	-0.061	29.018	0.219
*|. |	*|. |	26	-0.116	-0.081	31.089	0.186
.|. |	.|. |	27	-0.035	-0.020	31.279	0.218
.|. |	.|. |	28	-0.021	0.003	31.348	0.257
.|. |	.|. |	29	-0.064	-0.057	31.990	0.275
*|. |	*|. |	30	-0.076	-0.157	32.920	0.281
.|. |	.|. |	31	0.037	-0.053	33.137	0.317
.|. |	.|. |	32	0.053	0.001	33.596	0.343
.|. |	.|. |	33	0.020	0.036	33.661	0.387
.|. |	*|. |	34	-0.018	-0.135	33.716	0.433
.|* |	.|* |	35	0.129	0.162	36.545	0.351
.|. |	.|. |	36	0.013	0.042	36.575	0.396

the ACF and PACF are not significant until lag 36. This is indicates that the residuals are follow white noise process. The Ljung-Box test output also indicates the same results. The value of LB statistic until lag 36 is 36.575. This value is lower than the chi-square distribution value (X^2) with df = 36 and α = 0.05, which are 50.99. It means that the residuals are following white noise process. It can be concluded that ARIMA (1,1,0) model is the best fit model from the other tentative ARIMA model and can be used to modelling the data.

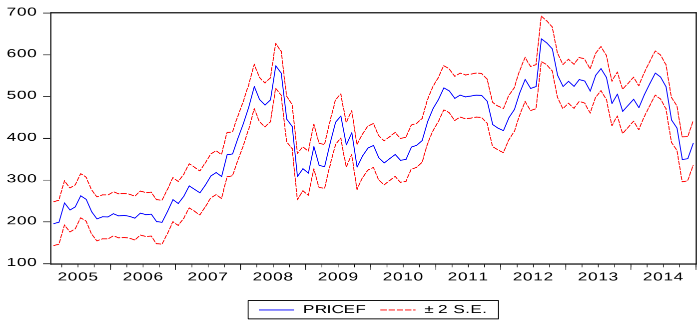
Forecasting

According to several previous steps, ARIMA (1,1,0) model is chosen as the appropriate model to forecast the international soybean prices. There are two kinds of forecasting: static forecasting and dynamic forecasting. Static forecasting used when actual value rather than forecasted value for the lagged variable and which can be performed only if actual data are available. Furthermore, dynamic forecasting calculated forecasts after the first period in the sample based on previously forecasted values of the lagged left-hand variable. This forecasting model can be evaluated by three indicators: Root Mean Squared Error (RMSE), Mean Absolute Error (MAE) and Mean Absolute Percent Error (MAPE). Generally those three values measure how close forecast to the eventual outcome. The lower value is beter. In this study the author will use the MAPE indicators because most of the people are more comfortable thinking in percentage terms and MAPE is more precise in one-model test.



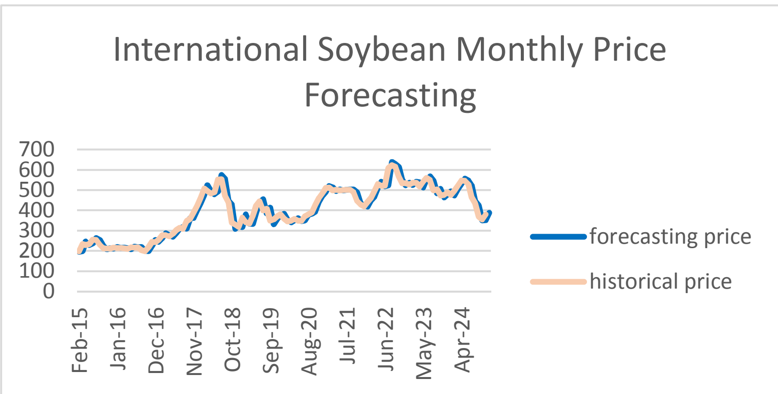
Forecast: PRICEF	
Actual: PRICE	
Forecast sample: 2004M12 2014M12	
Adjusted sample: 2005M02 2014M12	
Included observations: 118	
Root Mean Squared Error	133.2745
Mean Absolute Error	108.9787
Mean Abs. Percent Error	23.98522
Theil Inequality Coefficient	0.186625
Bias Proportion	0.637625
Variance Proportion	0.210286
Covariance Proportion	0.152089

Based on the figure, we can see the output of dynamic forecasting using ARIMA (1,1,0). From the graph it indicates that there are volatility trend of soybean price in the next ten years. The standard error bands that are given by the dotted red lines around conditional mean forecast are widening in the next ten years. This is indicates that the price will move more volatile and the risk that will be faced by soybean proce will increase in the next ten years. MAPE of this dynamic forecasting result is quite high with 23.98% which indicates it has large error.



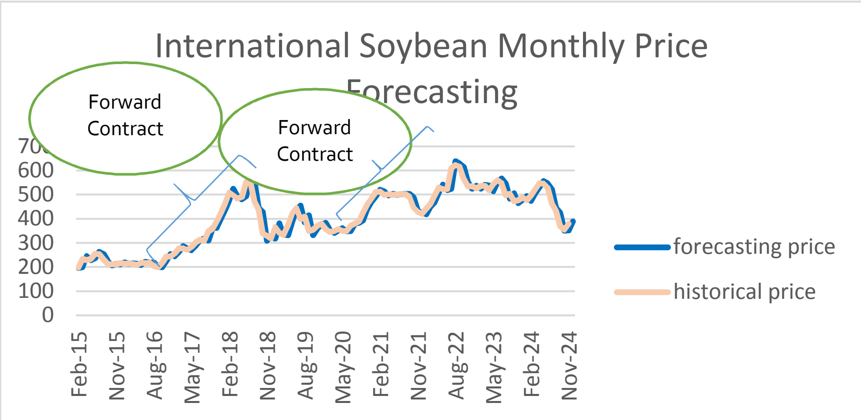
Forecast: PRICEF	
Actual: PRICE	
Forecast sample: 2004M12 2024M12	
Adjusted sample: 2005M02 2014M12	
Included observations: 118	
Root Mean Squared Error	25.96925
Mean Absolute Error	18.73867
Mean Abs. Percent Error	4.752445
Theil Inequality Coefficient	0.031183
Bias Proportion	0.000000
Variance Proportion	0.007997
Covariance Proportion	0.992003

The graph above shows forecast pattern for the mean and the box on the right side provided information about the forecast evaluation statistic. Based on figure 4.6, in forecast pattern we can see that the tendency of international soybean prices based on vactual value which fluctuates from time to time. MAPE of this static forecasting result is 4.75%. After we make the forecasting of international soybean monthly prices, we got the result of forecasting prices. The result showed in figure below:



As we can see from this graph above, the price predicted will increase at the beginning in period of February 2015 until June 2015. In August 2015 the price predicted will decrease until October 2015 and it will be stable until October 2016. After that, the price expected to rise sharply from November 2016 until June 2018. If we look back at the previous time, this increasing price was triggered by the decreased in soybean production in USA, Brazil, etc and it made the scarcity of soybean in the international market. This same situation could happen again in the future. Furthermore, the price predicted to have a great fall and reach the lowest point in November 2018. Then the price is expected to rise and fall again until December 2021 and it will have the increasing trend and it will rise sharply and hit the highest in August 2022. After hit the peak price in August 2022, it predicted to decline for the next two years until November 2024.

The international soybean price forecast pattern is utilized as a baseline to give recommendation toward risk in soybean industry area. The recommendation can be seen on the next graph:



The price volatility predicted will increase slightly in February 2015 until June 2015 but the price will decrease again and will be steady for the next one year until October 2016. After that, the price expected to rise sharply from November 2016 until July 2018. Based on that situation, the soybean processor should establish forward futures contract before October 2016 for period November 2016 until July 2018. As we know that the period of the forward futures contract are 30, 60, 90, 180, and 360 days, so that the soybean processor should split their forward futures contract into two contracts period. From November 2016 until November 2017 and December 2017 until July 2018. This forward futures contract is intended to hedge against that significant increasing price.

After that, the price predicted to have a great fall start from July 2018 until November 2018. It would be good for soybean processor because in November 2018, the price reach its lowest price for the period so that the soybean processor should buy soybean in large quantity in order to against the short uptrend of soybean which will start from December 2018 until July 2019. The price predicted to increase gradually from July 2020 until hits its highest poin in August 2022. The soybean processor should be aware for this uptrend. The soybean processor should establish establish forward futures contract again before Juny 2020 and the forward futures contract should be split into two contracts period again. From July 2020 until July 2021 and August 2021 until August 2022 in order to hedge against that increasing price. After that the price predicted to decrease gradually from September 2022 until November 2024.

Conclusion

Conclusion

The purpose of this research is to examine the pattern of international soybean price volatility and to forecast the international soybean monthly prices for the next one year. The model that utilized here is Autoregressive Integrated Moving Average (ARIMA). This research employed ARIMA because it can forecast the future price of international soybean monthly prices and give the information about the volatility likelihood from the result which is exist in time series data. There are six steps of forecasting procedures: testing for autocorrelation, testing for stationarity, identification of ARIMA model, estimating the parameter, diagnostic test/evaluating the model, and forecasting.

The main requirement of ARIMA model is the stationary of the time series data that we used. The time series data will stationare if the data moving shows the constant pattern from time to time, either its mean or the variance. In the model identification step, the result shows there are three models that might be appropriate to be used as forecasting model; ARIMA (1,1,0), ARIMA(0,1,1), and ARIMA(1,1,1). Based on the probability, Akaike Information Criteria (AIC) and Schwartz Criterion (SC) value criterions, ARIMA (1,1,0) model indicates that it can explain data better. After evaluation model step, ARIMA (1,1,0) is utilized to perform forecasting. The forecasting result shows there is the volatility in the future and the volatility risk will increase in the beginning and have the short uptrend and downtrend after that.

Based on the forecasting pattern, the price predicted will increase at the beginning in period of February 2015 until June 2015. In August 2015, the price predicted will decrease until October 2015 and it will be stable until October 2016. After that, the price expected to rise sharply from November 2016 until June 2018. Then it predicted to have a great fall and reach the lowest point in November 2018. After that the price will rise and fall again until Decemebr 2021 and it will have the increasing trend and hit the peak in August 2022. After hit the highest in August 2022, it predicted to decline for the next two years until November 2024.

Recommendation

According to the forecasting result, there is strategy that can be recommended for soybean industry to hedge against the volatility. The price predicted to rise sharply start from November 2016 until July 2018 so the soybean processor and importer especially should be prepared to establish forward futures contract before October 2016 for period November 2016 until November 2017 and December 2017 until July 2018 to lock the price against the upcoming trend that will come. Next the price predicted to have a great fall start from July 2018 until November 2018. The soybean processor and importer should buy soybean in a large quantity in order to against the short uptrend which will start form December 2018 until July 2019. After that the forward future contract shoukd be set once again to encounter with the upcoming trend which expected occur the next three years until August 2022.
High level of volatility indicates the high risk so the soybean processor can use the result of this research as the basis of their strategy in soybean industry in order to maximize the profit. The output of this study give insight about timing of hedging that has already described previously and to give insight about the future price of soybean in the next teen years. For further research, it can use the GARCH method to analyze the volatility of soybean more deeply. The future research can also consider using larger historical time series data that can lead to a better forecasting result and finding the factor that affect soybean price to make the analysis more deeply

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